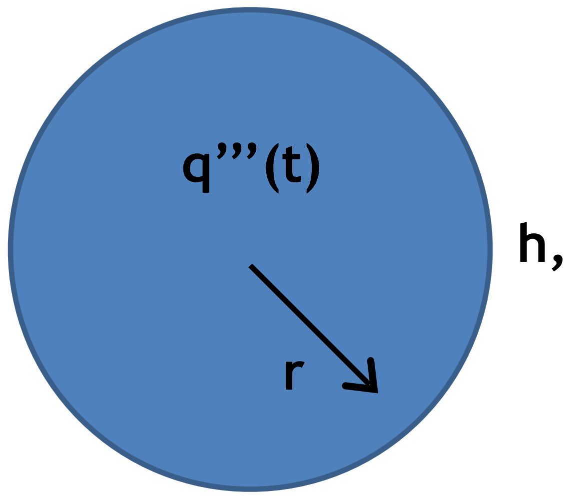
ME 6301

Computer Project

Heating of Lithium ion batteries during usage is a concern in many systems including laptops, electric vehicles, and aircraft. Consider a single cylindrical battery of Diameter D and height L placed vertically in quiescent air. Assume that the battery can be modeled with constant effective thermal conductivity and specific heat. During usage, the volumetric heat generation rate q''' (t) (W/m^3) can be provided as a function of time. The starting temperature is uniform at T_i and the battery surface is exposed to an ambient temperature of T_{inf} and effective heat transfer coefficient of h.



1. Assuming that the temperature within the battery can be described as T(r, θ, t), develop the governing equations and boundary conditions to determine the temperature field as a function of time using the finite volume method, as discussed in class.

2. Solve these equations and determine the temperature distribution and the maximum temperature for the following values:

   Battery size: D = 0.04 m, L = 0.152 m

   Volumetric heat generation rate (W/m^3); $q'''(t) = C_1 t^6 + C_2 t^5 + C_3 t^4 + C_4 t^3 + C_5 t^2 + C_6 t + C_7$

   Where, C_1=-1.7031E-11 , C_2=1.3146E-07 , C_3=-1.8011E-04 , C_4=1.024E-01, C_5=-2.8133E01, C_6= 3.6444E03, C_7 =-2.7545E03

   Battery properties: density (kg/m^3) = 2618, specific heat (J/kgK) = 950, thermal conductivity (W/mK) = 3 for all regions, except θ= 0 to 45°, where it is 1 W/mK

   Heat transfer coefficient (h): a low value of 2 W/m^2K, and a high value of 10 W/m^2K

   Assume Ti = 25 °C and the final time to be 630 s

3. Show that your maximum temperature prediction is both grid size and time step independent.

Assigned: March 6, 2013

Due: April 25, 2013